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DEPARTMENTS.

SOLUTIONS OF PROBLEMS.

ALGEBRA.

Problems 189 and 190 were also solved by L. E. Newcomb, Los Gatos, California.

190. Proposed by A. H. HOLMES, Brunswick, Maine.

Find the general term of the series 2, 3, 7, 46, 2112, etc.

Solution by G. B. M. ZERR, A. M., Ph. D., Parsons, W. Va., and GRACE M. BAREIS, Miss Roney's School, Bala, Pa.

Denoting the $n+1$ st term by T_{n+1} , we have the recursion formula $T_{n+1}=T_n^2-n$.

191. Proposed by NELSON L. RORAY, Bridgeton, N. J.

Find a number such that if it be multiplied by 2, 3, 4, 5, and 6, the cyclical order of its digits will not be changed.

Remark by L. E. DICKSON, Ph. D., The University of Chicago.

The answer is the period 142857, of the fraction $\frac{1}{7}$. Solved in the MONTHLY of 1895, p. 13, Algebra problem number 32.

GEOMETRY.

Problem 212 was also solved by F. D. Posey, A. B., San Mateo, California.

Problem 213 was also solved by L. E. Newcomb, Los Gatos, California, and F. D. Posey, A. B., San Mateo, California.

215. Proposed by M. J. NEWELL, A. M., Evanston High School, Evanston, Ill.

No satisfactory solution has been received.

216. Proposed by JOHN J. QUINN, Warren High School, Warren, Pa.

Find, by plane geometry, the sides of a right triangle if the hypotenuse is 35, and the side of the inscribed square is 12.

Solution by L. E. DICKSON, Ph. D., The University of Chicago.

"The inscribed square" to a right triangle is open to two interpretations: (1) the square has a side lying along the hypotenuse; (2) the square has two sides lying along the legs of the right triangle. For (1), the present problem is impossible (see problem 221). For the interpretation (2), denote the legs by a and b , $a \geq b$, whence $a^2 + b^2 = 35^2$. By similar triangles, $a - 12 : 12 = a : b$, whence $ab = 12(a + b)$. Adding and subtracting twice the latter from $a^2 + b^2 = 1225$, we get

$$(a+b)^2 - 24(a+b) = 1225, \quad (a-b)^2 = 1225 - 24(a+b).$$

Hence $a+b=49$, $a-b=7$, $a=28$, $b=21$. The geometric verification is evident.

Also solved by B. F. Finkel, A.M., M.Sc., 204 St. Marks Square, Philadelphia, Pa.; J. K. Ellwood, Principal Colfax Sub-District School, Pittsburg, Pa.; A. H. Holmes, Brunswick, Me.; and G. B. M. Zerr, A. M., Ph. D., Parsons, W. Va.; L. E. Newcomb, Los Gatos, California; G. I. Hopkins, Warren High School, Warren, Pa.; J. Scheffer, Hagerstown, Md.

217. Proposed by G. W. DRAKE, Fayetteville, Ark.

If one of the principal axes of a cone which stands on a given base be always parallel to a given right line, the locus of the vertex is an equilateral hyperbola or a right line according as the base is a central conic or a parabola. [Exercise 40, page 94, C. Smith's *Solid Geometry*].

Solution by WILLIAM HOOVER, Ph. D., Professor of Mathematics in the Ohio State University, Athens, O.

Let the given central conic be

$$x^2/a+y^2/b=1, \quad z=0 \dots\dots\dots (1),$$

and regarded as the central conicoid

$$x^2/a+y^2/b+z^2/c=1 \dots\dots\dots (2),$$

in which the semi-axis c vanishes.

This solution will employ the principle that the principal axes of a cone, which envelope a given conicoid, are normals to the three confocals which pass through the vertex. The confocals to (2) are given by

$$\frac{x^2}{a+\lambda} + \frac{y^2}{b+\lambda} + \frac{z^2}{c+\lambda}=1 \dots\dots\dots (3),$$

and so the confocals to (1), by

$$\frac{x^2}{a+\lambda} + \frac{y^2}{b+\lambda} + \frac{z^2}{\lambda}=1 \dots\dots\dots (4).$$

If (ξ, η, s) be the vertex of the cone, a normal to one of the system (4) is

$$\frac{[a+\lambda]}{\xi} \frac{[x-\xi]}{\xi} + \frac{[b+\lambda]}{\eta} \frac{[y-\eta]}{\eta} + \frac{[c+\lambda]}{s} \frac{[z-s]}{s}=1 \dots\dots\dots (5),$$

and if l, m, n be the direction-cosines of the given line, and ρ an undetermined number, we should have, for the normal to (4) at (η, ξ, s) ,

$$l=\frac{\rho\xi}{a+\lambda}, \quad m=\frac{\rho\eta}{b+\lambda}, \quad n=\frac{\rho s}{\lambda} \dots\dots\dots (6),$$

$$\text{giving } a+\lambda=\frac{\rho\xi}{l}, \quad b+\lambda=\frac{\rho\eta}{m}, \quad \lambda=\frac{\rho s}{n} \dots\dots\dots (7),$$

$$\text{and } l\xi+m\eta+ns=\rho\left(\frac{\xi^2}{a+\lambda} + \frac{\eta^2}{b+\lambda} + \frac{s^2}{\lambda}\right)=\rho \dots\dots\dots (8),$$